WHAT IS CLAIMED IS:

1. A microfluidic device comprising:

at least one sample-containment region capable of containing a sample;

at least one non-porous, gas-permeable sample sealing plug at least partially defining the at least one sample-containment region, and comprising a non-porous, gas-permeable material having a permeability coefficient at about 35° C relative to O_2 of at least about 8×10^{15}; and

an input opening in fluid communication with the sample-containment region.

2. The microfluidic device of claim 1, wherein the sample-containment region further comprises at least one sidewall that is gas-permeable and impermeable to water at 50 psi and at a temperature from about 25°C to about 95°C.

3. The microfluidic device of claim 1, wherein the non-porous, gas-permeable material comprises a polysiloxane material.

4. The microfluidic device of claim 1, wherein the non-porous, gas-permeable material comprises at least one material selected from polydimethylsiloxane materials, polydiethylsiloxane materials, polydiphenylsiloxane materials, polymethylethylsiloxane materials, polymethylphenylsiloxane materials, and combinations thereof.

5. The microfluidic device of claim 1, wherein the non-porous, gas-permeable material comprises a polydialkylsiloxane material.

6. The microfluidic device of claim 1, wherein the non-porous, gas-permeable material comprises a polydimethylsiloxane material.

7. The microfluidic device of claim 1, wherein the non-porous, gas-permeable material comprises the reaction product of an uncrosslinked reactive polysiloxane monomer and from about 0.01 percent by weight to about 50 percent by weight of a polysiloxane crosslinker.

8. The microfluidic device of claim 1, wherein:

the fluid communication comprises a channel between the input opening and the sample-containment region; and

the channel includes a valve.

9. The microfluidic device of claim 8, wherein the valve is in a closed state and the fluid communication through the channel is interrupted.

10. The microfluidic device of claim 1, wherein the at least one sample-containment region comprises a plurality of sample-containment regions and the at least one non-porous, gas-permeable sample sealing plug comprises a plurality of non-porous, gas-permeable sample sealing plugs.

11. The microfluidic device of claim 1, wherein the at least one sample-containment region comprises at least four sample-containment regions and the at least one non-porous, gas-permeable sealing plug comprises at least four non-porous, gas-permeable sealing plugs that respectively at least partially define the at least four sample-containment regions.

12. The microfluidic device of claim 1, wherein the at least one sample-containment region comprises at least 96 sample-containment regions and the at least one non-porous, gas-permeable sealing plug comprises at least 96 non-porous, gas-permeable material sealing plugs that respectively at least partially define the at least 96 sample-containment regions.

13. The microfluidic device of claim 1, wherein the at least one sample-containment region comprises at least 1,000 sample-containment regions and the at least one non-porous, gas-permeable sealing plug comprises at least 1,000 non-porous, gas-permeable material sealing plugs that respectively at least partially define the at least 1,000 sample-containment regions.

14. The microfluidic device of claim 1, wherein the at least one sample-containment region comprises at least 30,000 sample-containment regions and the at least one non-porous, gas-permeable sealing plug comprises at least 30,000 non-porous, gas-permeable material sealing plugs that respectively at least partially define the at least 30,000 sample-containment regions.

15. The microfluidic device of claim 1, wherein the at least one sample-containment region contains a sample disposed therein.

16. The microfluidic device of claim 1, wherein the sample-containment region contains a dried sample.

17. The microfluidic device of claim 1, wherein the sample-containment region further comprises at least one of a nucleic acid sequence probe or nucleic acid sequence primer disposed therein.

18. The microfluidic device of claim 17, wherein the at least one nucleic acid sequence probe or nucleic acid sequence primer is in a dried form.

19. The microfluidic device of claim 1, wherein the at least one sample-containment region comprises a plurality of sample-containment regions arranged in an array.

20. The microfluidic device of claim 19, wherein a selected plurality of the sample-containment regions contain one of a nucleic acid sequence probe, a nucleic acid sequence primer, or a sample containing an analyte of interest.

21. The microfluidic device of claim 19, wherein a selected plurality of the sample-containment regions containing a sample, a nucleic acid sequence probe, or a nucleic acid

sequence primer are arranged in one or more of a selected row or a selected column of the array.

22. A microfluidic device comprising:

at least one sample-containment region;

a non-porous, gas-permeable sample sealing cover layer at least partially defining the at least one sample-containment region and comprising a non-porous, gas-permeable material having a permeability coefficient at about 35° C relative to O_2 of at least about 8×10^{15}; and

an input opening in fluid communication with the at least one sample-containment region.

23. The microfluidic device of claim 22, wherein the at least one sample-containment region comprises at least one sidewall that is gas-permeable and impermeable to water at 50 psi and at a temperature from about 25°C to about 95°C.

24. The microfluidic device of claim 22, wherein the non-porous, gas-permeable material comprises a polysiloxane material.

25. The microfluidic device of claim 22, wherein the non-porous, gas-permeable material comprises at least one member selected from polydimethylsiloxane materials,

polydiethylsiloxane materials, polydiphenylsiloxane materials, polymethylethylsiloxane materials, polymethylphenylsiloxane materials, and combinations thereof.

26. The microfluidic device of claim 22, wherein the non-porous, gas-permeable material comprises a polydialkylsiloxane material.

27. The microfluidic device of claim 22, wherein the non-porous, gas-permeable material comprises a polydimethylsiloxane material.

28. The microfluidic device of claim 22, wherein:

the fluid communication comprises a channel between the input opening and the at least one sample-containment region; and

the channel includes a valve.

29. The microfluidic device of claim 28, wherein the valve is in a closed state and the fluid communication through the channel is interrupted.

30. The microfluidic device of claim 22, wherein the at least one sample-containment region comprises a plurality of sample-containment regions and the non-porous, gas-permeable sealing cover layer at least partially defines the plurality of sample-containment regions.

31. The microfluidic device of claim 22, wherein the at least one sample-containment region comprises a plurality of sample-containment regions and the non-porous, gas-permeable sealing cover layer interrupts fluid communication from one of the plurality of sample-containment regions to the others of the plurality of sample-containment regions.

32. The microfluidic device of claim 22, wherein the at least one sample-containment region comprises at least four sample-containment regions and the at least one non-porous, gas-permeable sealing cover layer comprises at least four non-porous, gas-permeable material sealing cover layers that respectively at least partially define the at least four sample-containment regions.

33. The microfluidic device of claim 22, wherein the at least one sample-containment region comprises at least 96 sample-containment regions and the at least one non-porous, gas-permeable sealing cover layer comprises at least 96 non-porous, gas-permeable material sealing cover layers that respectively at least partially define the at least 96 sample-containment regions.

34. The microfluidic device of claim 22, wherein the at least one sample-containment region comprises at least 1,000 sample-containment regions and the at least one non-porous, gas-permeable sealing cover layer comprises at least 1,000 non-porous, gas-permeable material sealing cover layers that respectively at least partially define the at least 1,000 sample-containment regions.

35. The microfluidic device of claim 22, wherein the at least one sample-containment region comprises at least 30,000 sample-containment regions and the at least one non-porous, gas-permeable sealing cover layer comprises at least 30,000 non-porous, gas-permeable material sealing cover layers that respectively at least partially define the at least 30,000 sample-containment regions.

36. The microfluidic device of claim 22, wherein the sealing cover layer comprises a sealing strip.

37. A microfluidic device comprising:

at least one sample-containment region;

at least one non-gas-permeable material at least partially defining the at least one sample-containment region;

at least one venting region in fluid communication with the at least one sample-containment region; and

at least one non-porous, gas-permeable sealing device at least partially defining the at least one venting region and comprising a non-porous, gas-permeable material having a permeability coefficient relative to O_2 at about 35° C of at least about $8x10^{15}$.

38. The microfluidic device of claim 37, wherein the gas-permeable sealing device comprises a cover layer.

39. The microfluidic devices of claim 37, wherein the gas-permeable sealing device comprises a sealing plug.

40. The microfluidic device of claim 37, wherein the at least one venting region further comprises at least one sidewall that is gas-permeable and impermeable to water at a water pressure of 50 psi and at a temperature from about 25°C to about 95°C.

41. The microfluidic device of claim 37, wherein the non-porous, gas-permeable material comprises a polysiloxane material.

42. The microfluidic device of claim 37, wherein the non-porous, gas-permeable material comprises at least one material selected from polydimethylsiloxane materials, polydiethylsiloxane materials, polydiphenylsiloxane materials, polymethylethylsiloxane materials, polymethylphenylsiloxane materials, and combinations thereof.

43. The microfluidic device of claim 37, wherein the non-porous, gas-permeable material comprises a polydialkylsiloxane material.

44. The microfluidic device of claim 37, wherein the non-porous, gas-permeable material comprises a polydimethylsiloxane material.

45. The microfluidic device of claim 37, wherein the non-porous, gas-permeable material comprises the reaction product of an uncrosslinked reactive polysiloxane monomer and from about 0.01 percent by weight to about 50 percent by weight of a polysiloxane crosslinker.

46. The microfluidic device of claim 37, wherein:

the fluid communication comprises a channel between the venting region and the sample-containment region; and

the channel includes a valve.

47. The microfluidic device of claim 46, wherein the valve is in a closed state and the fluid communication through the channel is interrupted.

48. The microfluidic device of claim 37, wherein the at least one venting region comprises an exit port.

49. The microfluidic device of claim 37, wherein the at least one non-porous, gas-permeable sealing plug comprises a plurality of non-porous, gas-permeable sealing plugs.

50. The microfluidic device of claim 49, wherein each one of the plurality of one non-porous, gas-permeable sealing plugs respectively partially defines at least one venting region of a plurality of venting regions.

51. The microfluidic device of claim 37, wherein the at least one venting region comprises a plurality of venting regions and the at least one non-porous, gas-permeable sealing plug comprises a plurality of non-porous, gas-permeable sealing plugs.

52. The microfluidic device of claim 37, wherein the at least one venting region comprises at least four venting regions and the at least one non-porous, gas-permeable sealing plug comprises at least four non-porous, gas-permeable sealing plugs that respectively at least partially define the at least four venting regions.

53. The microfluidic device of claim 37, wherein the at least one venting region comprises at least 96 venting regions and the at least one non-porous, gas-permeable sealing plug comprises at least 96 non-porous, gas-permeable material sealing plugs that respectively at least partially define the at least 96 venting regions.

54. The microfluidic device of claim 37, wherein the at least one venting region comprises at least 1,000 venting regions and the at least one non-porous, gas-permeable sealing plug comprises at least 1,000 non-porous, gas-permeable material sealing plugs that respectively at least partially define the at least 1,000 venting regions.

55. The microfluidic device of claim 37, wherein the at least one venting region comprises at least 30,000 venting regions and the at least one non-porous, gas-permeable sealing plug

comprises at least 30,000 non-porous, gas-permeable material sealing plugs that respectively at least partially define the at least 30,000 venting regions.

56. The microfluidic device of claim 37, wherein the at least one sample-containment region comprises a plurality of sample-containment regions and the at least one non-gas-permeable cover layer comprises a plurality of non-gas-permeable cover layers that respectively at least partially define the plurality of sample-containment regions.

57. The microfluidic device of claim 37, wherein the at least one sample-containment region comprises at least four sample-containment regions and the at least one non-gas-permeable cover layer comprises at least four non-gas-permeable cover layers that respectively at least partially define the at least four sample-containment regions.

58. The microfluidic device of claim 37, wherein the at least one sample-containment region comprises at least 96 sample-containment regions and the at least one non-gas-permeable cover layer comprises at least 96 non-gas-permeable cover layers that respectively at least partially define the at least 96 sample-containment regions.

59. The microfluidic device of claim 37, wherein the at least one sample-containment region comprises at least 1,000 sample-containment regions and the at least one non-gas-permeable cover layer comprises at least 1,000 non-gas-permeable cover layers that respectively at least partially define the at least 1,000 sample-containment regions.

60. The microfluidic device of claim 37, wherein the at least one sample-containment region comprises at least 30,000 sample-containment regions and the at least one non-gas-permeable cover layer comprises at least 30,000 non-gas-permeable cover layers that respectively at least partially define the at least 30,000 sample-containment regions.

61. A method for venting a gas from a microfluidic device comprising:

providing a microfluidic device, the microfluidic device comprising;

at least one sample-containment region capable of containing a sample;

at least one non-porous, gas-permeable sample sealing plug at least partially defining the at least one sample-containment region, and comprising a non-porous, gas-permeable material;

an input opening in fluid communication with the sample-containment region;

loading a liquid into the microfluidic device; and

venting a gas from the microfluidic device through the at least one non-porous, gas-permeable sample sealing plug.

62. The method of claim 61, wherein the non-porous, gas-permeable material comprises a material having a permeability coefficient at about 35° C relative to O_2 of at least about 8×10^{15}.

63. The method of claim 61, wherein the non-porous, gas-permeable material comprises a polysiloxane material.

64. The method of claim 61, wherein the non-porous, gas-permeable material comprises at least one member selected from polydimethylsiloxane materials, polydiethylsiloxane materials, polydiphenylsiloxane materials, polymethylethylsiloxane materials, polymethylphenylsiloxane materials, and combinations thereof.

65. The method of claim 61, wherein the non-porous, gas-permeable material comprises a polydialkylsiloxane material.

66. The method of claim 61, wherein the non-porous, gas-permeable material comprises a polydimethylsiloxane material.

67. The method of claim 61 further comprising applying a gas-impermeable membrane to the at least one non-porous, gas-permeable sample sealing plug.

68. The method of claim 61, wherein the microfluidic device includes a channel in fluid communication with the sample-containment region, and the method further includes interrupting fluid communication through the channel.

69. A method for venting a gas from a microfluidic device comprising:

providing a microfluidic device, the microfluidic device comprising;

at least one sample-containment region capable of containing a sample;

at least one non-porous, gas-permeable sample sealing cover layer at least partially defining the at least one sample-containment region, and comprising a non-porous, gas-permeable material;

an input opening in fluid communication with the sample-containment region;

loading a liquid into the microfluidic device; and

venting a gas from the microfluidic device through the at least one non-porous, gas-permeable sample sealing cover layer.

70. The method of claim 69, wherein the non-porous, gas-permeable material comprises a material having a permeability coefficient at about 35° C relative to O_2 of at least about 8×10^{15}.

71. The method of claim 69, wherein the non-porous, gas-permeable material comprises polysiloxane material.

72. The method of claim 69, wherein the non-porous, gas-permeable material comprises at least one member selected from polydimethylsiloxane materials, polydiethylsiloxane materials, polydiphenylsiloxane materials, polymethylethylsiloxane materials, polymethylphenylsiloxane materials, and combinations thereof.

73. The method of claim 69, wherein the non-porous, gas-permeable material comprises a polydialkylsiloxane material.

74. The method of claim 69, wherein the non-porous, gas-permeable material comprises a polydimethylsiloxane material.

75. The method of claim 69, further comprising applying a gas-impermeable membrane to the at least one non-porous, gas-permeable sample sealing cover layer.

76. The method of claim 69, wherein the microfluidic device includes a channel in fluid communication with the sample-containment region, and the method further includes interrupting fluid communication through the channel.

77. A method comprising:

providing a microfluidic device including a plurality of sample-containment regions;

loading the plurality of sample-containment regions with a sample to form loaded sample-containment regions; and

sealing the loaded sample-containment regions with a non-porous, gas-permeable material cover layer.

78. The method of claim 77, further comprising:

loading a nucleic acid sequence probe or a nucleic acid sequence primer into selected sample-containment regions.

79. The method of claim 78, wherein the nucleic acid sequence probe or the nucleic acid sequence primer is loaded into the loaded sample-containment regions.

80. The method of claim 78, wherein the nucleic acid sequence probe or the nucleic acid sequence primer is loaded prior to loading the plurality of sample-containment regions with the sample.